PROJECT facts

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Sequestration

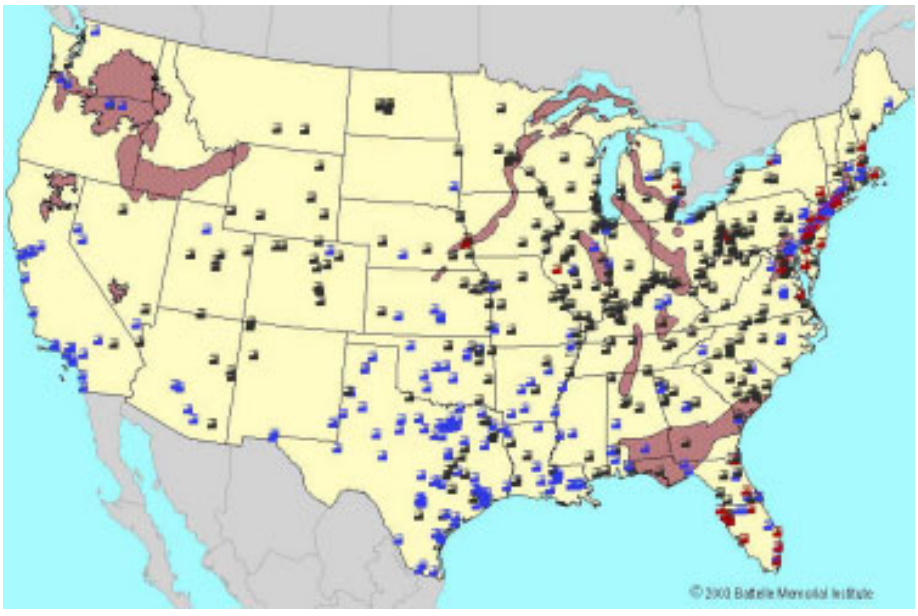
02/2004

CO_2 SEQUESTRATION IN BASALT FORMATIONS

Background

There is growing concern that the buildup of greenhouse gases, especially CO_2, in the atmosphere is contributing to global climate change. One option for mitigating this effect is to sequester CO_2 in geologic formations. Numerous site assessments for geologic sequestration of CO_2 have been conducted in virtually every region of the U.S. For the most part, these studies have involved storing CO_2 in saline aquifers, deep coal seams, of depleted oil and gas reservoirs. Another option, however, is basalt formations. Basalt is an aluminum silicate that contains basic ions, such as sodium and calcium, that can combine with CO_2.

Basalt formations have not received the attention they deserve with respect to their potential for permanent sequestration of anthropogenic CO_2. Major basalt formations that may be attractive for carbon sequestration occur in the Pacific Northwest, the Southeastern U.S., and at several other locations around the world. Unlike sedimentary rock formations that have received much attention, basalt formations have unique properties that will result in chemically trapping the injected CO_2, thus effectively and permanently isolating it from the atmosphere.



Distribution of major basalt formations in the U.S. along with coal (black), oil(red), and natural gas(blue) power plants

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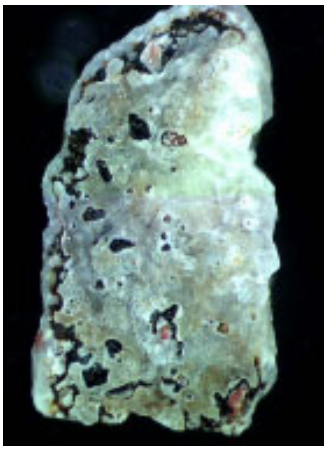
PARTNERS

Pacific Northwest National Laboratory (PNNL)

COST

Total Project Value:
$400,000

DOE/Non-DOE Share:
$400,000 / $0

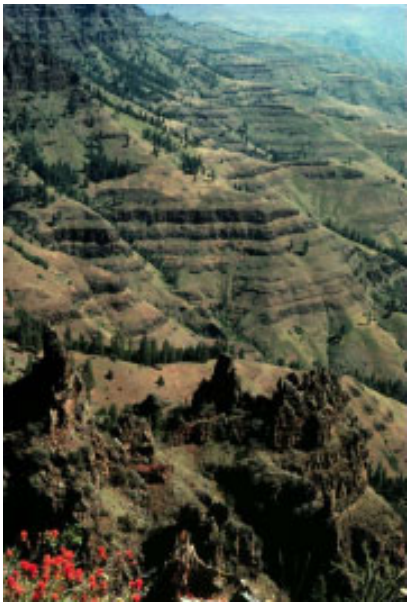


Close-up picture of a basalt grain that has been reacted with supercritical CO_2 - the white crystals coating the grain are calcite.

Because of the very limited study of basalts for carbon sequestration, basic information on injectivity, storage capacity, and rate of conversion of gaseous CO_2 to solid carbonates is not available. Preliminary experiments conducted at Pacific Northwest National Laboratory (PNNL) have confirmed that carbonate mineral formation occurs when basalts from the Columbia River Basalt Group (CRBG) are exposed to supercritical CO_2. However, insufficient data have been generated from these experiments to permit reliable projections of CO_2 conversion rates under large-scale sequestration conditions. Information is also lacking on the ability of basalts from other parts of the U.S. to support in situ mineralization reactions.

Primary Project Goal

The primary goal of this project is to evaluate the capacity of basalt formations for CO_2 storage and to determine the rate of conversion of injected CO_2 to carbonates. The principal focus is on the Central Atlantic Mafic Province in the Southeastern U.S., but there is also interest in the Columbia River Basalt Group in the Pacific Northwest.



Picture of an outcrop of Columbia River Basalt showing the multiple layers resulting from the periodic lava eruptions

Objectives

- To determine mineralization kinetics for CO_2 conversion to carbonates.
- To conduct tomography on the Basalt Flow Top.
- To determine CO_2 storage capacity in basalt formations.

Accomplishments

- Completed a set of dissolution kinetics measurements as a function of temperature and pH on Columbia River basalt.
- Carbonate mineralization was verified by optical and scanning electron microscopy, x-ray diffraction, and Raman spectroscopy.
- The reservoir capacity of the Columbia River Basalt Group was estimated using existing geologic data obtained from prior DOE-RW studies.
- Core samples and geologic data for the Central Atlantic Mafic Province basalts have been obtained.

Benefits

Because of concern over the impact of greenhouse gases, particularly CO_2, on global climate change, considerable effort is being expended evaluating the potential of CO_2 sequestration to mitigate the buildup of CO_2 in the atmosphere. Success of this project will expand the viable geologic options for CO_2 sequestration in the continental U.S. and provide heretofore unexplored options for CO_2 sequestration in developing countries, such as India and China.